From Imagination to Experience: The Role of Feasibility Studies in Gathering Requirements for Ambient Intelligent Products

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Abstract. From a User-Centered Design perspective, technology pushes are often regarded to as negative because the ideas behind these pushes not always address user needs, often causing products to fail in the market. Feasibility studies help close the gap between technology pushes and demand pulls. By inviting users to witness feasibility studies in an early stage of a design process, participants not only are able to provide input long before full functionality has been developed, but it also allows them to make that important step from imagining what an Ambient Intelligent product can do for them in their daily lives, to actually experiencing it.

1 Introduction

The Ambient Intelligent vision of having electronic environments that are aware and responsive to the presence of people [1] has set a direction for companies to design products that bring this vision to life. From a User-Centered Design (UCD) perspective, the technology developments behind these products can range from being *technology pushes* to being *demand pulls*. A *technology push* is driven by ideas coming from the creative minds of developers trying to perfect their technical solutions in the absence of specific needs that customers may have, attempting to find some minimum use case that justifies its existence [7][9]. This is contrasted by the *demand pull* [9] which is driven by user needs and requirements.

UCD techniques for gathering requirements and participatory design, involving users early on in the design process, include the use of Cultural Probes [4], Technology Biographies [2], Technology Probes [6], Role-Playing and Low-fi Prototyping [8], and Ethnographic Design Research [3][5] among others. While these techniques are successful in the process of gathering user requirements for new designs and concepts, they often rely on the participants' abilities to imagine what an ambient intelligent system is and what it can do for them in their daily lives. By inviting participants to witness the results of a feasibility study conducted in HomeLab, we allowed participants shift from imagination to experience.

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1.1 Feasibility Study in HomeLab

Early on in the process of designing an ambient lighting system for the bathroom, our team had to answer a basic question: would people want to have functional and ambient lighting in their bathrooms to support their activities? To answer this question, we conducted a user study that included interviews, using Cultural Probes [4] and inviting users to participate in a workshop in HomeLab.

Philips Lighting conducted a feasibility study by installing a demonstration of state-of-the-art lighting in the bathroom of HomeLab in Eindhoven, the Netherlands. The demo was made to show different modes (Night, Wake-up, Day, Relax, Beauty light) that created functional as well as ambient atmospheres using light intensity, colour temperature of white light, coloured light and transitions. Different light sources (LEDs, incandescent, halogen) were installed, which produced both coloured and white light (ranging from cold to warm in colour temperature), as well as different intensity levels combined with dynamic changes. This demonstration was used as the starting point for the workshop to explore together with the participants the different options that such a system could provide.

2 User Study

We conducted a User Study in which we introduced participants to Cultural Probes that they would use for a period of one week. Later on, they were invited to participate in a workshop in HomeLab where they were able to witness the feasibility demonstrator of the bathroom lighting system.

The goal of this study was to gain an insight into whether people would want atmospheric and functional lighting to support their daily activities in the bathroom and if yes, how. This required recruiting a diverse population of participants to address different needs.

There were practical reasons for splitting the user study in these two very distinct phases, namely the first part was focused on gathering knowledge on users' activities in their homes while the second part would be dedicated to presenting the demo thus allowing participants to experience an ambient lighting system.

Because in the first part of the study participants would only be asked to imagine what ambient intelligent lighting could do, it was interesting for us to see their reactions before and after seeing the demo. Our assumption was that their answers would somehow differ.

2.1 Participants

We aimed to recruit at least ten participants for our study to ensure different viewpoints. We focused on five families (couples) mainly because they would provide a richer look into simultaneous sharing situations in the bathroom. We wanted to know whether people actually share their bathroom at the same time and if lighting should support these activities while sharing. Another question that families could help an-

swer is how would such a lighting system react to the presence of multiple users. The second criterion was to find families that had medium-to-large bathrooms in their house. An average Dutch house (where the study took place) has relatively small split bathrooms (compared to American households); usually a separate toilet and a small sink on the ground floor and a shower and sink on the first floor. Such small houses provided only limited possibilities to look into sharing situations or have spaces for multiple-lighting.

Fig. 1. This image is a collection of pictures that were made by participants and sent back to us as part of the Cultural Probe study

2.2 Cultural Probes

The first part of the User Requirements study consisted of sending Cultural Probes to the participants' homes. These probes consisted of a *diary*, which contained assignments to answer *questions,* indicate events on *timelines*, and *activities*, and a disposable camera to allow participants to take pictures for the period while they were filling-in their diaries. The Cultural Probe study took place in January 2004 in the participants' homes.

The primary purpose of the Cultural Probe study was to gain insight into what people do in the context of the bathroom, including *activities*, *places* and *objects* used while performing these activities. The second purpose was to start a discussion on *lighting*, namely their current lighting conditions in the bathroom and identify any problems they may be experiencing with light. We were also interested in gathering input from participants on whether they would be open to experience light in new ways in their bathroom, through coloured light, changes in intensity and transitions, and whether this type of lighting should support their activities in a functional way. Additionally, participants were asked to take pictures to visually support and highlight some of the experiences they had while filling-in the *diaries*.

We conducted an interview in the participants' homes where they were introduced to the *diaries*, going generally through every page to answer questions that could arise. They were then given disposable cameras and asked to keep track of their pictures in a *picture record* table. The facilitator with the help of the participants made a

floor plan drawing of their bathroom so they could keep track of the places where they were performing their activities as well as sharing situations.

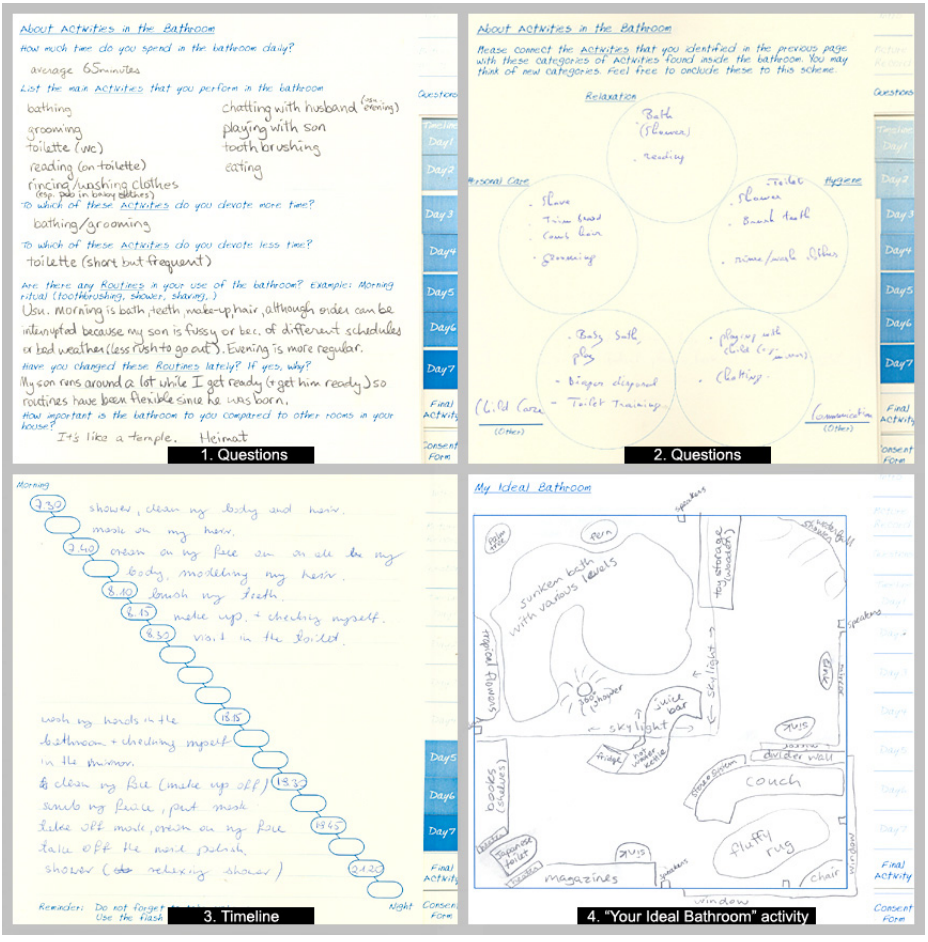

Fig. 2. These are samples of pages from the Diaries that were filled-in by participants as part of the Cultural Probe study

The main advantages of this way to elicit requirements included collecting data from participants over a period of one week, something that formal interviews do not allow because they usually last no longer than a couple of hours. A one-week period allowed the participants to reflect on what they were being asked as well as on the answers they provided on the previous days. Another advantage of the probes was that they provided better conditions for participants to answer questions on a topic that most of them would not feel comfortable to give answers to during a formal interview. Participants had the time to think on what they wanted to answer thus preventing uncomfortable face-to- face situations.

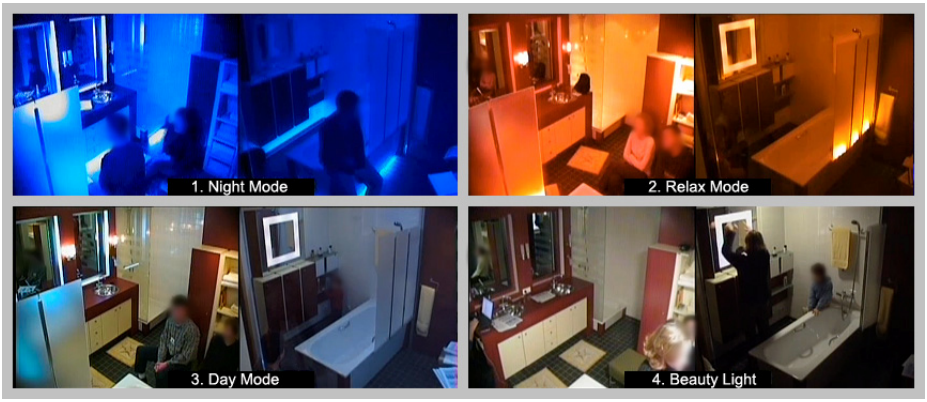

Fig. 3. This image is a collection of pictures that were made during the Workshops while participants were experiencing the different modes.

2.3 Workshops

The second part of the study consisted of Workshops that took place in February 2004 in HomeLab. The feasibility study conducted by Philips Lighting resulted in a demonstrator of advanced bathroom lighting that was presented as a series of sequential modes that correspond to different times of the day as well as different activities.

The main objective of the Workshops was to allow participants to witness and have a first-hand experience with the concepts proposed for bathroom lighting, as well as coloured lighting, transitions and changes in intensity. In this way, we were able to gather requirements from the participants through their reactions on the system as it was implemented, as well as trigger their imagination for new ideas. The second purpose was to encourage participants to modify settings to fit their specific needs/wishes.

Participants were welcomed to the HomeLab by the facilitator who led them to the bathroom. Participants were given an overview of what the Workshop was about and were informed that the session would be recorded on DVD (video and audio).

The Workshop started by inviting participants to take a seat after which lights were switched off to allow their eyes to get used to complete darkness (there are no natural light sources in this bathroom).

The bathroom lighting demonstrator was presented in a sequence of modes that include a Night Mode, a Wake-up Mode, a Day Mode, a Relax Mode and the Beauty Light. Scenarios were used to give participants a context of the occasion and time in which each mode would most probably be used.

3 Study Results

This workshop proved to be a key point in demonstrating the difference between asking participants to imagine an ambient lighting system for the bathroom and letting them actually experience such system.

3.1 What People Said on an Ambient Lighting System Before Witnessing the Demonstrator

Although the main focus of the Cultural Probes study was to explore activities inside the bathroom, two specific questions on lighting were asked, namely should lighting functionally support their activities in the bathroom and would coloured lighting or changes in intensity be part of this support. Their previous experiences with such lighting systems were limited to the use of candles in the context of the bathroom. At this point, participants said they would not like to have such a system in their bathrooms.

While most of the initial assumptions related to the activities performed in the bathroom by users were confirmed, the most important finding from the diaries was the request for functional lighting that supports activities in the bathroom, mainly through having more sources of white light in their bathrooms, with the option to dim light. The other important finding was the unanimous reluctance to have coloured lighting in the context of the bathroom.

At this point in the study, it was very difficult for participants to have a clear idea on the full range of possibilities that an advanced lighting system could offer. The depth of their ideas was limited by their abilities to imagine such a system at work.

Although they identified other important aspects in their use of the bathroom, namely *sharing*, *routines* and *differences in use between weekdays and weekend*, participants did not proactively initiate remarks on how these aspects could help make an ambient lighting system suit their needs in a better way.

3.2 What People Said on an Ambient Lighting System After Witnessing the Demonstrator

Participants were invited in HomeLab to experience the lighting system demonstrator installed in the bathroom. By witnessing the demonstrator, participants were able to shift from imagination into actually experiencing what coloured lighting, changes in intensity and transitions, actually meant. All participants expressed their desire to have such a lighting system in their bathroom which is a remarkable opinion change as expressed earlier during the Cultural Probes.

The overall impression about the different Modes presented during the demo was very positive. All participants found the concepts behind the six Modes (Night, Wake-up, Day, Relax, Artistic and Beauty Light) attractive. From the very beginning of the demonstration, after all the modes were presented, all participants were enthusiastic about the new *modes*. Participants generated more ideas on what they would want from such a system.

The feasibility study not only helped them see what coloured lighting could do in the bathroom. It also triggered their imaginations allowing us to gather requirements on *lighting* and the *modes* themselves as well as on other specific aspects such as *colour, indirect lighting, seasonal effect, duration of transitions, triggering and controlling modes,* and *colour temperature of white light.*

One aspect where participants had been unable to provide input was the question on how such a system should react to situation where two or more users share the bathroom simultaneously. After the demo, all families proactively engaged in a short

friendly discussion on how the system should react to sharing situations, without having the facilitator explicitly ask participants about it. The general conclusion from these discussions is that the problem should be solved by the couple according to common social rules and not by the system. Participants said the way the problem would be solved would depend on the circumstances of the encounter (activity, mood, day, duration, level of disruption depending on how much the overall lighting would actually be affected).

4 Discussion

There are several issues that should be taken into account considering the outcomes of the current study. First of all, there is a question on what are the factors that influence this strong shift from expressing no need in having coloured lighting and dynamic transitions in the first phase of the study, to being so unanimously enthusiastic about the demonstrator showing these features. The main reason for such a strong difference in opinion may be the fact that in the first case it was very hard for participants to imagine what coloured lighting could look like or could do for them in the context of the bathroom. In that sense, the feasibility study conducted by Philips Lighting which resulted in a demonstrator for ambient lighting in the bathroom proved to be crucial for breaking the barrier between imagination and direct experience.

The experience we had in the current study with the advanced lighting system can be true also for other ambient intelligent systems. Since people are not familiar with the possibilities these systems have to offer it would be difficult to collect valid requirements for such systems if people would need to imagine those systems. Their opinion can change 180 degrees after they would have experienced such systems, similar to what happened in our study.

The different nature of diaries and workshops may also have an effect in the outcome of this study. The diaries may have felt like a cumbersome and boring school-like activity where they have to do their homework for a period of one week. This could have had a negative effect on the breadth of their answers. On the other hand, the workshops are mainly based on participants verbalizing on what they are seeing. Their ability to express what they like and dislike may have an influence on the final output. The limited time, as well as the social interaction during the workshops may have prevented participants from getting a full picture of the system.

There was a very clear positive effect on the participants' attitude after seeing the demonstration and remained constant throughout the workshop. The overall attitude from the participants towards the entire activity may be influenced by the nature and duration of the task. Here again, this could be a matter of discussion since cultural probes are a one-week task where people keep track of their daily activities in the bathroom compared to a three-hour workshop where people are stimulated by seeing something novel and that will only require them to concentrate for a short period of time.

5 Conclusions

When gathering requirements for new Ambient Intelligent products, allowing participants to go from imagination to experience by inviting them to witness and evaluate advancements in technology at an early stage of the development of the product makes a big difference. We believe the findings of our study confirmed the importance of conducting feasibility studies to help bridge the technology push-demand pull gap. By inviting users to give their views at this early stage of the design process, users can have a say into how this systems would work, be controlled and be tailored to their needs.

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